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Experiment Station

THE MARCRAFT FLOOR-LEVELING SYSTEM FOR URBAN REHABILITATION

Abstract. A speedy and efficient system has been developed for installing wooden screeds that can be used as a base for laying a level new floor over an old sagging floor. The screeds are held in position by means of a new leveling device, and rigid urethane foam is sprayed under the screeds to hold them permanently in a level position.

A Big Opportunity

Urban rehabilitation—now being vigorously promoted by Federal, state, and local governments—has created a vast potential market for new construction materials and a need for faster and cheaper installation methods. The Federal Housing Administration has estimated that in our cities some 9½ to 10 million dwelling units need rehabilitation.

For an example, take New York City. Here there are some 43,000 buildings, mostly 5 and 6 story walk-ups that were erected before the City's 1903 building codes went into effect; and most of them need rehabilitation today. Though these buildings are generally in deplorable condition, the basic structures are sound; they have solid 16-inch brick external walls and 4-by-12-inch floor joists.

One unique feature is that these buildings are almost all identical: 25 feet wide and 85 feet long, with floor joists spanning the full width. They contain some 480,000 apartments, the so-called "railroad flats", consisting of a series of rooms connected by doorless openings.

The FHA has estimated that urban rehabilitation in New York City alone would require 580 million square feet of new floors and an equal amount of new ceilings, 116 million square feet of new roofs, 6.3 million square feet of new windows, 4 million square feet of new doors, and 2.3 billion square feet of new walls.

The wood-products industry is eyeing this potential new market. Already on the market, or being developed, are such new products as panelized strip flooring, self-adjusting wall panels, adjustable wooden windows, and prefabricated wooden kitchen-bathroom units. The key to use of many of these new products is a level floor.

The Problem of Floors

The big problem is that, though the buildings are structurally sound, the floors in most of them have sagged during the past 65 years. In some buildings the sag is as much as 8 inches. In most the sag ranges between 2 and 4 inches.

Complicating the problem is that the sag is in two directions. The floors sag toward the central stairwells, which have settled considerably, pulling the floor joists down with them. And they sag in the middle, because the full-width floor joists have settled under the weight of load-bearing walls.

The key to rapid rehabilitation of these apartment interiors is a level floor. This establishes a level reference surface that lends itself to extensive use of prefabricated components requiring a minimum of on-site fitting. The use of these prefabricated units such as walls, prehung doors, closets, wall paneling, cabinets, kitchens, and bathrooms reduces the time required for installation and lowers on-site costs.

Without first establishing a level floor, most of the advantages of prefabricated components are lost because each piece must be fitted, shimmed, or adjusted to correspond with the irregular floor surface. Thus time and costs go up, and the results are about the same as if the old conventional remodeling methods were used.

A Solution

In an attempt to provide a remedy for sagging floors, scientists at the U. S. Forest Service's Forest Products Marketing Laboratory at Princeton, W. Va., with the technical assistance of the Union Carbide Chemicals Company of South Charleston, W. Va., and the Gusmer Coatings Company, Inc., of Woodbridge, N. J., have developed the Marcraft floor-leveling system.

In this new system, a leveling device is used to hold 2-by-2-inch wooden screeds in a level position over the old floors; and a cushion of urethane foam is sprayed under and around the screeds to bond them to the old floor and make a level foundation for a new floor.

Tried in a railroad flat in New York City, the Marcraft system has

proved to be a fast, economical, and structurally sound way of rehabilitating sagging old floors. With this system two men can establish a level floor-bearing base in a 12-by-12-foot room in less than 14 minutes, at a cost for labor, materials, and equipment of less than 7 cents per square foot—about $9.65 for a 12-by-12-foot room.

The leveling device.—Several devices for leveling the wooden screeds were designed and developed by scientists at the Forest Products Marketing Laboratory.

The ones used in the study consisted of two 7-foot long by 1¾-inch square aluminum tubes. These tubes are attached with two machine-fitted bands so that the tubes may be adjusted in length from 7 feet to 13 feet by sliding one tube along the other.

The ends of each tube are fitted with a ⅝-inch diameter screw that is threaded through the tube. The screws have a crank at the top and a 3-inch swivel at the base. The length of the screws allows the leveling devices to be adjusted from 0 to 10 inches in height.

Each tube has 3/16-inch holes drilled at 6-inch intervals along its entire length to provide for attaching it to the wooden screeds with duplex nails.

Several other variations in bar design have shown promise. One is the use of spring clamps instead of duplex nails to hold the screeds to the leveling devices, thereby decreasing screed-attachment time. Another is the use of pinch clamps and smooth rods instead of screws for adjusting height of the bars. This would reduce the time required to bring the screed-bar system up to a level position.

The leveling bars serve two functions: they establish a level or straight edge for the tops of the screeds, and they temporarily support the level screeds at specified spacings while the foam is being sprayed beneath them (fig. 1). Using the height adjustments at each end of the bars, the tops of all the screeds in a room can be brought to a level plane at one time. This reduces time and labor costs considerably.

Installation procedure.—Installing the floor screeds is simple. Before the installation crew arrives, someone marks where the top of the new floor is wanted by use of a string chalk line or some similar means. The height of the new floor depends upon how many rooms are to be leveled to the same plane. If each room is to be leved independently, this step is not necessary since the bars can be leveled by using a carpenter's level.

Because the room dimensions are generally known, the wooden screeds can be cut to room length in advance.

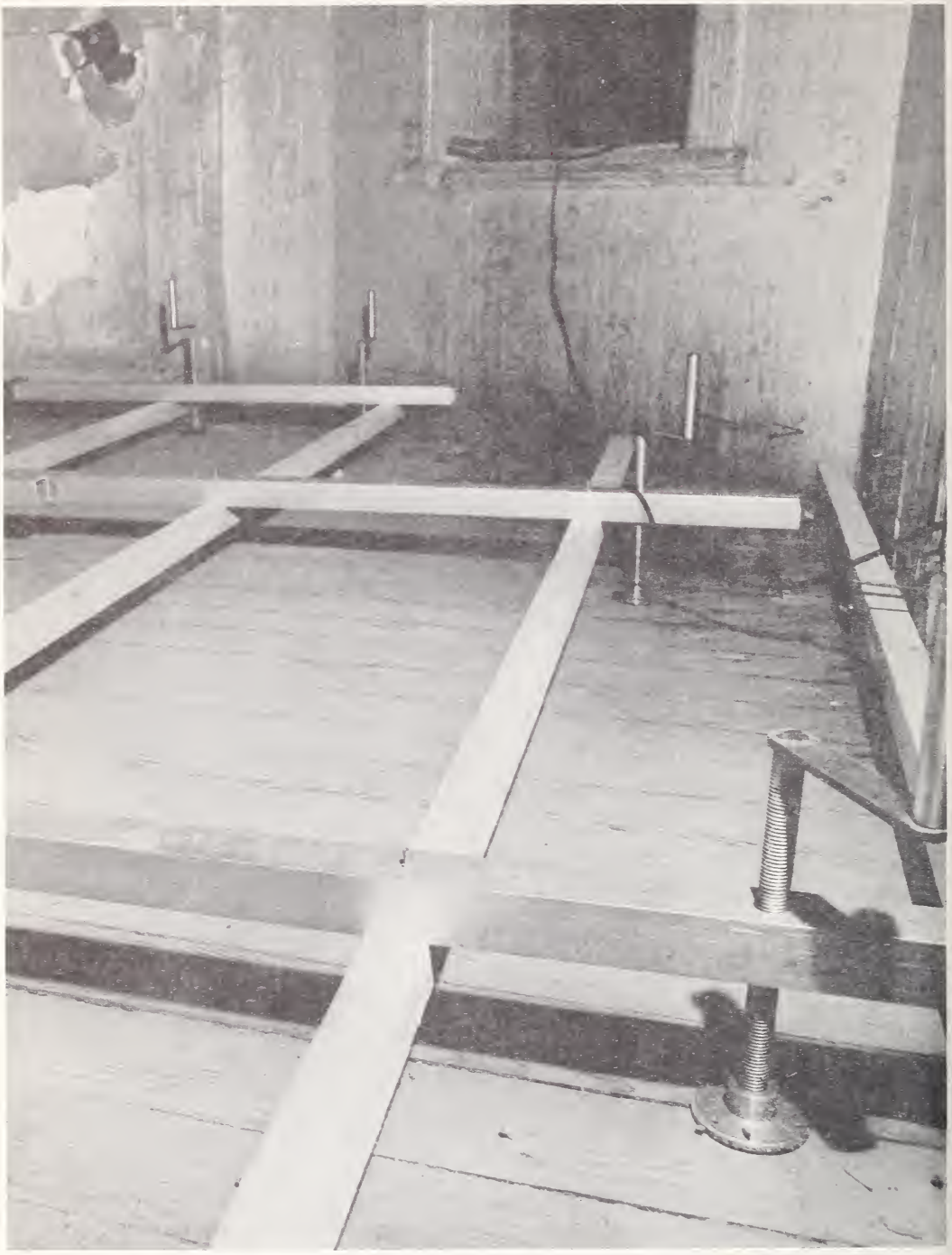

Figure 1.—The 2-by-2-inch wooden screeds held in level position over the old sagging floor by means of the new floor-leveling device. Note the screw jacks on the leveling bars for making fast height adjustments.

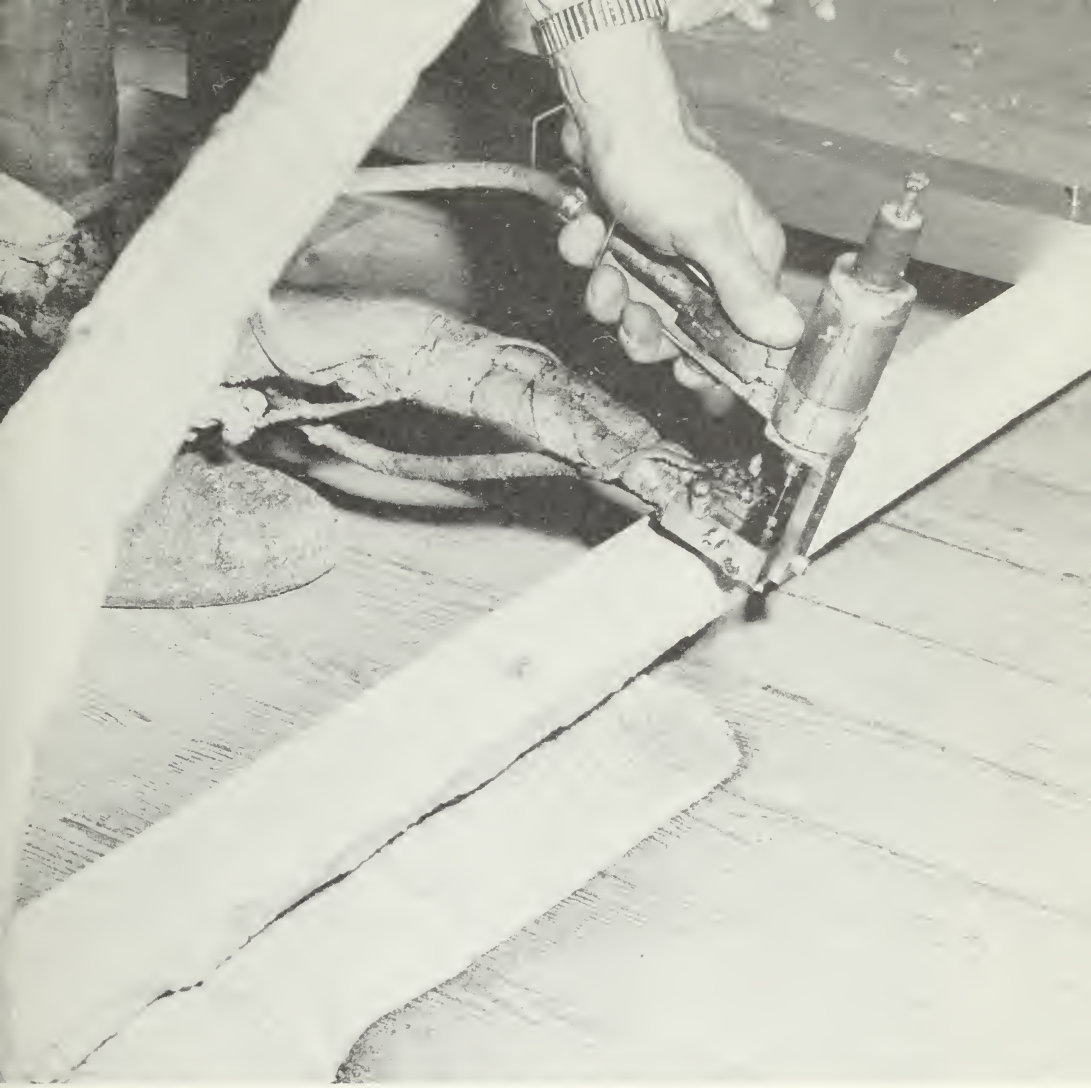

Figure 2.—Spraying the urethane foam to fill the sag-space beneath the new floor support. The foam expands 36 times to form a rigid and permanent bond and base for the floor screeds.

Figure 3.—Ready for a new floor. The new floor supports in this room have more than 10 times the normal design strength for residential construction.

Procedures for installation are as follows: First the precut screeds are placed at the approximate desired spacing over the existing floor. Then the leveling devices are placed over the screeds approximately 1 foot from the wall and perpendicular to the screeds. The screeds are nailed to the bar at predetermined spacings, using No. 10d duplex nails. Then the tops of the screeds are brought up to the level reference line on the walls by raising the leveling bars with the screw height adjusters.

The frothed rigid urethane foam is then sprayed between the floor and the bottoms of the screeds (fig. 2). After 5 minutes the duplex nails are pulled, and the leveling bars are moved to the next room to be leveled; and the procedure is repeated (fig. 3).

The most efficient size of crew for this job would be three men. Two men would level the screeds before foaming and would remove the leveling bars after foaming, and the third man would operate the foaming equipment and do the foaming. With three men the work load is balanced and no idle or waiting time would be involved.

The urethane foam.—The chemicals and formulation used to produce the rigid urethane foam were supplied by Union Carbide Chemicals Company.[1] They consisted of a basic resin and an activator. The development of the foam is caused by the production of gases within the liquid mixture of the two chemicals during a polymerization process.

[1]Mention of a particular product should not be taken as an endorsement by the Forest Service or the Department of Agriculture.

The warmed chemicals expand immediately to six times their original volume upon leaving the gun in a frothed condition—like aerosol shaving cream—and then expand six more times as the chemical action takes place to form the rigid foam, a total expansion of 36 times their initial volume in the storage containers. The speed of expansion and curing of the foam is controlled by the amount of activator in the formulation and the temperature of the chemicals.

As the foam expands, it becomes very tacky and adheres to any clean surface it touches. Consequently the foam not only supports the wooden screeds, but if the floor is clean, it also bonds the screeds to the floor.

The foam used with this system weighs only 2 pounds per cubic foot, so it adds little load to the floor. It has good heat resistance, withstanding temperatures of 250°F., is self-extinguishing when ignited, and is highly resistant to fungus growth.

Although the rigid urethane foam appears fragile, the foam-supported wooden screeds placed on 2-foot centers provide 10 times the normal design strength for residential floor construction.

The foaming equipment.—The application equipment used in perfecting the system was designed and patented by Gusmer Coatings Company, Inc., of Woodbridge, N. J., and is sold under the name of GUSCO Process Equipment. In general, the GUSCO system consists of: (1) chemical storage containers for each chemical; (2) transfer pumps and proportioning pumps to supply the correct amounts of each chemical; (3) chemical heaters that are thermostatically controlled to maintain the liquids at spray temperature; (4) 200 feet of special hoses, electrically heated and insulated to maintain the chemicals within the line at spray temperature, to transfer the chemicals to the gun block; and (5) a spray gun that contains a mixing chamber and necessary controls to keep the two basic liquids from mixing before the spray valve is operated.

The entire system can be mounted on a 2-wheel trailer, pickup truck, or carry-all truck for easy transportation between jobs. The only external power requirement is a source of 220-volt single-phase electric power to operate the compressors and heaters.

The Time and Cost

Estimated costs and times for leveling 12-by-12-foot rooms having an average sag of 2 to 3 inches, using the Marcraft floor-leveling system with screeds on 2-foot centers, are as follows:

- Cost of 2-by-2-inch wooden screeds @ $0.40 each; 7 screeds = $2.80 or $0.0194 per square foot.
- Cost of leveling screeds; two carpenters, each at $7.12 per hour, requiring 6 minutes. Cost is $1.42 or $0.0099 per square foot.
- Cost of foam at $0.46 per pound, using 1¼ pounds per screed, total of 8¾ pounds of foam = $4.02 or $0.0279 per square foot.
- Cost of foaming equipment and operator at $10 per hour. Equipment cost = $25 per day for power, repairs, and depreciation, plus one operator's salary. Time required is 8 minutes = $1.33 or $0.0093 per square foot.
- Total time required.
  a. 3-man crew: 14 minutes total or 0.097 minutes per square foot.
  b. Man-minutes used: 20 man-minutes total or 0.139 man-minutes per square foot.
- Total cost of leveling per square foot of floor area.

a. Screeds	$0.0194
b. Leveling	.0099
c. Foam	.0279
d. Operator	.0093
Total	$0.0665/square foot

All costs and times are conservative, and they include such items as moving from room to room. As purchasing quantities increase and greater proficiency is obtained, the total costs should decrease. However, it should be stressed that these are actual costs and do not allow for supervision costs, overhead costs or profit margin.

The Marcraft floor-leveling system provides the advantages of simplicity, flexibility, speed, and economy that are required in the urban rehabilitation work of today. A program is under way to develop a construction scheme that would make possible the rehabilitation of an entire apartment building in 48 hours. If only 1 cent per square foot were saved by using this system, the potential total savings for the New York City rehabilitation project alone could be over 5.8 million dollars.

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